Swamp Works – Multiple Projects

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Abstract

My Surface Systems internship over the summer 2013 session covered a broad range of projects that utilized multiple fields of engineering and technology. This internship included a project to create a command center for a 120 ton regolith bin, for the design and assembly of a blast shield to add further protection for the Surface Systems engineers, for the design and assembly of a portable four monitor hyper wall strip that could extend as large as needed, research and programming a nano drill that could be utilized on a next generation robot or rover, and social media tasks including the making of videos, posting to social networking websites and creation of a new outreach program to help spread the word about the Swamp Works laboratory.

Nomenclature

Ghz	=	Gigahertz
GPU	=	Graphic Processing Unit
HD	=	Hard Drive
OS	=	Operating System
RAM	=	Random Access Memory
ton	=	metric ton (1000kg)

I. Introduction

The Surface Systems laboratory at the John F. Kennedy Space Center in Florida also known as "Swamp Works" was the destination of my summer 2013 internship. During my internship, I participated in multiple projects while applying multiple different skill sets. I began with acquiring a list of projects that were assigned to me by my mentor Meredith Chandler and various others. I began working on the command center that houses and utilizes 4 Dell computers, each equipped with dual monitors. This command center would be used to operate 'Big Bin', the 120 ton regolith container, for use of controlling different rovers and cameras inside. The command center would also display weather information and other necessary data, as well. I was also given a project to convert an old 70" table into a blast shielded box to add an additional layer of protection to the Surface Systems engineers. Another project that was assigned was a mobile hyper-wall with the ability for expansion. The hyper wall had to be completely designed and researched from scratch. I was asked to help research and program a nano drill given to us by the HoneyBee Robotics lab at the Jet Propulsion Laboratory (JPL). Finally, I created multimedia presentations for the NASA Kick Start projects and other miscellaneous videos to post on social networking websites. This kept followers informed on the projects occurring in the Swamp Works lab.

II. Project Backgrounds

The projects assigned to me utilized different skill sets and methodologies; each requiring special attention to detail and understanding. This section of the report explores the starting information and background of each project attempted during this internship.

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A. Command Center

To begin housing experiments for the RASSOR rover prototype, the 120 ton regolith bin needed a central command center to track the experiments appropriately. Swamp Works was given retired Dell computers that were originally placed in inventory; these computers were assigned to me for the use of creating the Central Command Center. For terminal housing, I was given the option to either use salvaged command station units, or design a center myself. The terminal units needed some cleaning and adjusting; however, I eventually decided to utilize the salvaged units. With assistance from my mentor, I incorporated keyboards and mice in conjunction with the Command Center. Each monitor and machine required only minor adjustments and assembly.

B. Table Top Blast Shield

I was assigned to create a table top blast shield to protect the engineers who test equipment that could be potentially harmful if malfunctioning were to occur. I designed the project in Creo-2 and measured the dimensions on the table that will support the completed box. This was my crash course in engineering software and I was guided through the process by some of the engineers in my lab. Once the design was completed, Jason Schuler assisted me in ordering the appropriate materials and the build would take place once the parts had arrived. It was also proposed to use gas shocks to take the majority of the weight off of the hinges. The material used would be 80/20 aluminum and the build was estimated at approximately 1 week.

C. Mobile Hyper-Wall

A mobile hyper-wall would be a very valuable asset to have, to lend, and potentially even sell. I was assigned the task of designing the structure, choosing and quoting materials, building hardware, configuring software, and other various tasks that would ultimately get the wall up and running. After design, hardware research was required to support hosting of the four monitor strips. Proper software was required to match up the correct display segments. 80/20 aluminum building material was found to be sufficient in supporting the hyper-wall and lessened build time significantly. The build time for 5 units of hyper wall strips was estimated at 1 week.

D. Nano Drill

The nano drill acquired from HoneyBee Robotics is unique in that it can reduce its x and y axis forces in order to drill more efficiently in low gravity environments. HoneyBee provided an insight into the idea of what motion controller and OS we could utilize. The nano drill is a rotary percussive drilling instrument that can be attached to any platform or rover. I was tasked to assist Jason Schuler in research, design, and programming the drill itself.

E. Media and Social Networking

Successful outreach to social media can help educate the public along with creating a following for the lab. I was assigned to help my mentor with social networking projects, video recording for various projects, and creating an outreach program for the Swamp Works lab. When tasked with creating videos about the KickStart NASA program, we created videos interviewing some of the engineers from multiple angles for a stronger and intimate video effect. We were then able to load the clips into iMovie to edit them appropriately. We also sought to brainstorm a few ideas on the promotion of the Swamp Works lab and initiating a weekly or bi-weekly video release about the projects in the lab. Along with video creation, updating social media, such as Facebook and Twitter, was also partially assigned..

F. Miscellaneous Projects

Throughout the internship, I was able to assist engineers with the construction of the regolith bin. I worked on the Don/Doff area as well as the large dual bin doors that swivel with the use of hinges. I also printed components with the 3D printer as needed. Any miscellaneous jobs the lab employees required were assigned to me including painting, cleaning, and other physical work..

III. Implementation

This section of the report consists of the methods used to construct and execute the planned operations. Pictures of works in progress are included.

A. Command Center

The stock of excess Dell machines was located in the storage closet. I was informed the machines were freshly formatted and contained no Operating Systems (OS). I then found a suitable OS that is both open source and is able to operate the lab software required. Ubuntu 12.04 Linux based OS was open source and supported a multitude of lab software. I installed the OS on each machine and created username and passwords respectively. I began cleaning the command terminals and adjusting the dimensions to sufficiently store the 22" Dell monitors that were to be used for this project. I began preparing each machine by installing the Linux based OS and changing graphics processing units (GPU) as seen fit. Each machine is fitted with a 2.4 Ghz dual core processor containing 4GB of RAM. Once the installation portion of the project was complete, I began pairing each machine with two monitors in their corresponding terminals. I then ran power from each monitor and tower to their appropriate power strip. Two extension cords, secured with hazardous caution tape, were run from a nearby outlet across a path to ultimately power up each terminal. Kennedy Space Center does not allow permanent extension cords for power; therefore, a work order for power had to be placed and the need for installation of additional outlets was also determined. A guide to Linux was printed to inform the engineers how to operate each terminal.

Figure 1. Table Four Computer Com Center. *Each computer was equipped with dual monitors, a keyboard and a mouse. The Command Center took approximately 1 week to fully setup.*

B. Table Top Blast Shield

Safety of all engineers/employees at Swamp Works is critical. I transformed an old table into a blast shield to serve as added protection while testing equipment that has potential for failure. I began designing the project in the Creo-2 software and gained knowledge as the project progressed. Before this design process I had no experience with any CAD software. Upon measuring the table, I found the dimensions to be 72x35x25 (l*w*h) in inches. Figure 2 shows the CAD design of the box shell. The build took place on the 8th of July and was completed the following day. With guidance from some of the engineers in the lab, I was able to create the design and even set the densities of each material to acquire an accurate final weight, which is approximately 150 lbs. After the main build was completed, we designed additional support in order to attach hinges. Gas shocks were also installed to support the weight and ultimately make it easier to operate. The gasket sealing was inserted into the lexan to complete the project.

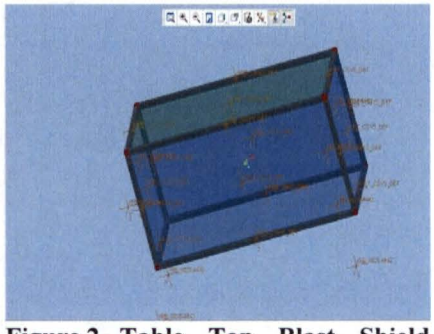


Figure 2. Table Top Blast Shield Design. *Design of this project took approximately 2 days to complete. 4442 models were retrieved from http:/www.3dcontentcentral.com*

C. Mobile Hyper-Wall

The prospect of a mobile hyper-wall would increase productivity and appeal of any lab. Our visions of a hyper-wall consisted of being mobile and have the potential to be mass-produced to create various sizes. The ability to attach and combine in that the entire wall could be transported quickly, with ease, was important. The wall also had to be sturdy, light, and simplistic-looking.

With the design requirements understood, design of the hyper-wall began in the Creo2 software. 80/20 building material was determined to be sufficient due to the strength and weight properties of the P/N# 1515 80/20 aluminum material. I also utilized 80/20 for brackets and hinges. Casters and cord sleeves were ordered from McMaster.com.

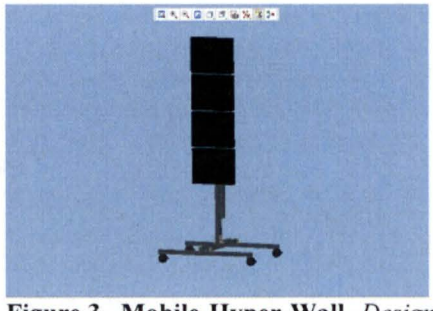


Figure 3. Mobile Hyper-Wall. *Design of this project took approximately 5 days to complete. Some models were retrieved from http:/www.3dcontentcentral.com*

In Figure 4 you can see some of the brackets that would be joining the stand to the base. A static calculation revealed that the length of the bottom supports were appropriate to handle the moment of the upper monitors. Each stand is equipped with a wire chute to adequately handle the cords of the entire setup. It was also proposed to put a plate on the bottom so the computer tower can join into stand itself.

I quoted five of the mobile hyper wall stands via a supplier from Orlando. The first quote of the project came back at $3064.14. The cost of each stand would equate to $612.83 (see Figure 6). This price was too high, therefore,

I needed to find a cheaper supplier of caster wheels and wire enclosures. Jason Schuler and I began researching casters and mounting plates on McMaster.com in order to find more moderately priced items. After further research we settled on casters and cord enclosures from McMaster.com and lowered the final cost of the project to a grand total of $1817.54. This brought the cost of each stand to $363.51, which was a price difference of $249.32 per stand. Once the quote was approved by Rob Mueller, the parts were ordered. I was then given the assignment of researching methods to set up the hyper-wall. The hardware required to run 20 monitors was scarce and expensive. Jon Welch at Ames Research Laboratory referred me to literature on previous designs and architecture of hyper-walls. He also led me to a Wikipedia page and was my go-to on hyper-wall-related issues.

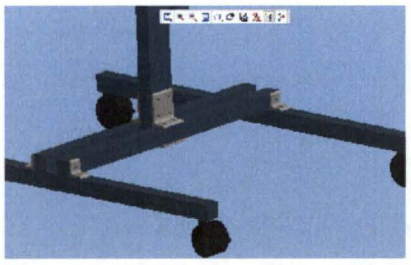


Figure 4. Mobile Hyper-Wall. *Design of this project took approximately 5 days to complete. Some models were retrieved from http:/www.3dcontentcentral.com*

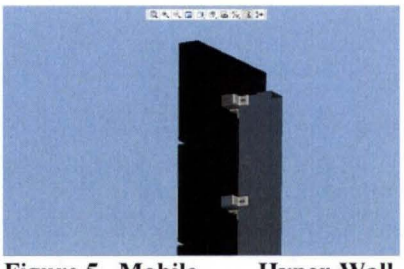


Figure 5. Mobile Hyper-Wall. *Design of this project took approximately 5 days to complete. Some models were retrieved from http:/www.3dcontentcentral.com*

	A	B
1	80-20 Part Number	Qty.
2	4302	110
3	2333	22
4	4285	12
5	4366	6
6	3278	200
7	3286	50
8	3279	50
9	13041	70
10	3330	250
11	2030-Plain	45
12	2045-Plain	10
13	2899	35
14	3487	105
15	2426	22
16	3110	88
17	1515-BL Cut to length (inches)	Qty.
18	40	10
19	30	10
20	4.875	30
21	6	10
22	1530-BL Cut to length (inches)	Qty.
23	73	5

Figure 6. Hyper-Wall Quote *Quote for 5 builds of mobile hyper-wall.*

D. Nano Drill

We were provided with a nano drill and operating instructions from Honeybee Robotics at the Jet Propulsion Laboratory in California. This drill could be placed on a next-generation rover used for collection of ice and regolith. We would be utilizing an Elmo Duo motion controller (Figure 7), the nano drill itself, and other components needed to network the drill to the computer. After attending a teleconference and ordering the proper connectors for the motion controller assembly, we began doing research on how to get the drill up and running. Proper connectors were ordered, and we began discussing the construction and operation of the drill itself. It would be a joint project with HoneyBee and would require their expertise; however, my internship completed before we could further work the project.

Figure 7. Elmo Motion Controller. *The Elmo Duo motion controller was recommended by the HoneyBee Robotics lab.*

E. Media and Social Networking

Social networking is an extremely effective way for educational outreach of users who are interested in robotics and spacecraft. When combined with media, it creates an interactive showcase for individuals who follow the Swamp Works team. By working closely with my mentor Meredith Chandler, we were able to design an effective, yet entertaining outreach program for the Swamp Works lab. We created mandatory explanation videos for the NASA Kick Start program. Utilizing the Swamp Works studio and the iMovie software, we were able to produce videos 2 minutes in length about each of the Kick Start proposal.

We began discussing how to implement a weekly or bi-weekly video about the evennts at the Swamp Works laboratory. Humorous and interesting media captures the viewer's attention and maintains it throughout the video. We also discussed video length and export control issues; it would also be best to have an interview associated with recorded green screen footage maximize time allowance.

F. Miscellaneous Projects

Throughout my time at Swamp Works I was tasked with miscellaneous projects that ranged from working on the 'Big Bin' to cleaning the lab. Most of my miscellaneous projects dealt with construction and labor on the 120 ton Lunar Regolith Bin.

I was assisted in the building of the don/doff area with two other interns as one of my first projects for Swamp Works. We began by laying out the 80/20 in its configuration and acquiring the proper brackets and bolts for the task. After organizing the parts, we began the assembly; this took approximately one week to complete. We then began inserting the lexan plexiglass material, which required proper squaring of the structure. A rubber gasket was also added for dust-proofing, followed by doors and handles.

After don/doff assembly (Figure 8), there were other small tasks with the bin including cleaning the bin, rolling out the cover tarp, and capping some of the 80/20 end pieces for aesthetic purposes. A shipment of additional 80/20 building material arrived we began laying out the design for the two large bin doors. After laying the skeleton of the door we started assembling and squaring the project. Lexan was inserted which required additional squaring measurements. Once the lexan was secure we placed the rubber gasket for the dust proof seal and began on the next door. The total door assembly took approximately 2 days. Once both doors were assembled, we started the process of attaching them to the Big Bin. It was challenging to raise the top door to the proper position, but with the scissor lift and ingenuity we were able to secure them in their proper place. After the bottom door was secured, we began working on the challenge of aligning the two doors to their appropriate positions. Once the doors were aligned we were able to place the rubber gasket in order to keep dust strictly inside of the bin.

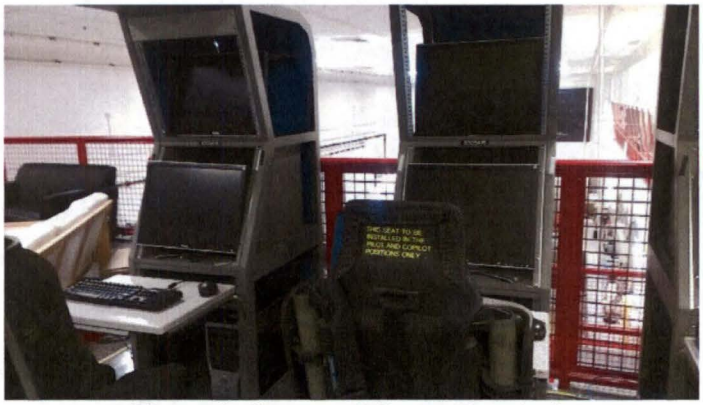
Figure 8. Don/Doff
In this area the engineers will be putting on respirators and clean suits.

Figure 9. Bin Doors
These doors will be used for entry and exit for robots and rovers.

Aside from bin projects I cleaned, painted, and 3D printed parts that were used for miscellaneous designs. The parts that were 3D printed were used in the don/doff doors, cubes for the blast shield, and test drill enclosures for the sample capture project.

IV. Additional Pictures

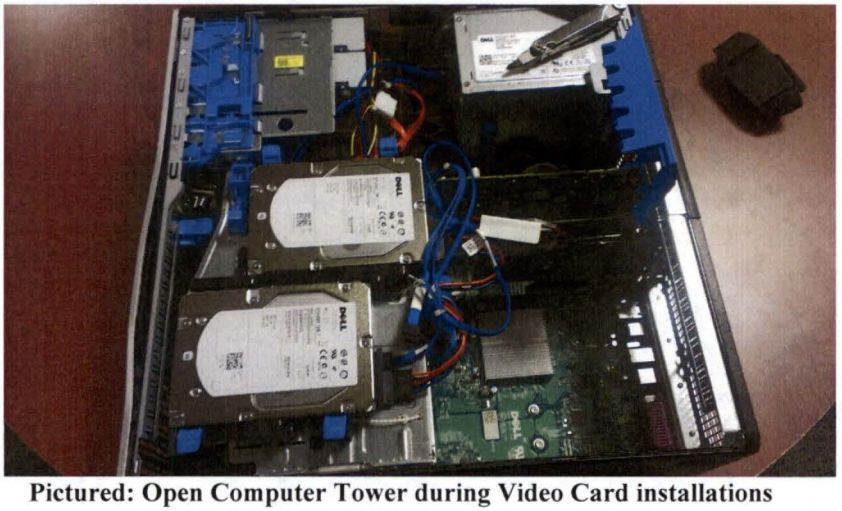
Pictured: Table Top Blast Shield



Pictured: Command Center Terminals

Pictured: The 'Big Bin' project

Pictured: Painted Tool Cabinets



Pictured: Open Computer Tower during Video Card installations

V. Conclusion

Each project assigned was completed to the best of my ability. I successfully created a blast shield and mobile hyper-wall. The command center is up and running with Linux based operating systems. The Big Bin is now almost fully completed and the research on the nano drill is complete and is at its component building stage. The idea for social media educational outreach has been talked about and a plan has been constructed. My Surface Systems summer internship has been incredibly fulfilling and educational. Before the internship began, I had never touched CAD software or even built the smallest structure. I can now call myself proficient with CAD software and have two designs and builds under my belt. I have also quoted building materials and hosted meetings. Working at NASA has always been a dream of mine and I finally feel like I've taken the first steps in making that dream come true.

Acknowledgments

I want to thank my mentor Meredith Chandler for everything she has done to help guide me through my internship at the Swamp Works lab, and my unofficial mentor, Jason Schuler for answering a multitude of questions regarding Mechanical and Civil Engineering. Thank you to Rob Mueller for inspiring me and providing guidance in my journey to become a NASA employee, and to Jack Fox for assigning me challenging and engrossing projects to keep me productive. I also want to thank the Swamp Works engineers: Rachel Cox, Tom Lippit, Drew Smith, Andrew Nick, and all the other employees at Swamp Works who have helped guide me along my path. Finally I would like to thank USRP for the funding; without their support, I would have never had this opportunity.

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